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# MANGO PULP AND NECTAR PROCESSING IN MALI

A Technical and Financial Analysis for the Malian Investor

INTEGRATED INITIATIVES FOR ECONOMIC GROWTH IN MALI



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## **Acronyms**

CIP	Cleaning in Place
COGS	Cost of goods sold
DDP	Deliver Duty Paid
EBIT	Earnings before interest and taxes
EU	European Union
FDA	Food and Drug Administration
ff	Fresh Fruit
FOB	Free on Board
HAACP	Hazard Analysis at Critical Control Point
NFC	Not from Concentrate
Ppm	Pieces per minute
RM	Raw material

## Sommaire (français)

Introduit par un bref aperçu des marchés internationaux de la purée de mangue, ce document décrit les procédés unitaires et les équipements nécessaires pour la transformation de la purée de mangue. Il fait d'une part une analyse détaillée des options d'emballage pour la purée de mangue en vrac et le nectar de fruit en pochettes et d'autre part, une analyse financière de la rentabilité d'une ligne de production de purée de mangue et d'une ligne qui intègre les opérations de transformation de purée de mangue avec celles de l'emballage du nectar en pochettes.

L'Inde domine le marché mondial de pulpe de mangue avec 113 000 MT de production et 67% des exportations mondiales. Il est le plus grand producteur de la variété de mangue la plus reconnue dans la fabrication du purée; Alphonso.

Le Moyen-Orient est le premier importateur de mangue. Plus de 25% des mangues exportées au niveau mondial sont consommées au Moyen Orient. Il est suivi de l'Asie et Amérique du Nord. L'Union Européenne quant à elle, achète la purée de mangue en des quantités relativement petites ; seulement 4% des exportations mondiales, mais le marché de la purée de mangue augmente depuis les années 1990 et la tendance devrait se poursuivre.

La Mali produit environ 500 000 tonnes de mangue par an sur lesquelles seulement 10 000 tonnes sont exportées à l'état frais et de nos jours il n'existe aucune unité de production de pulpe de mangue au Mali. Ce qui fait de la filière mangue une filière à très faible valeur ajoutée au Mali.

Pourtant, la production de la purée de mangue est bien possible au Mali, le processus étant relativement simple. Les étapes nécessaires dans la transformation de la mangue sont : le lavage, le dénoyautage/pulpage, le traitement thermique, l'homogénéisation, la pasteurisation et l'emballage. C'est l'emballage aseptique qui est exigé, l'équipement pour ce dernier représente un des principaux coûts d'investissement. Pour approximativement \$840 000, il est possible de mettre en place une usine de production de purée de mangue d'une capacité de transformation de 2.5 tonnes de mangues fraîches par heure. En se référant sur le coût des matières premières et le prix de la purée de mangue sur le marché mondial, le bénéfice annuel généré par une telle installation peut être estimé entre \$74,000 et \$242,000.

Enfin, il est techniquement et financièrement faisable d'ajouter une ligne de remplissage au chaud pour le nectar de mangue. Le produit final de cette ligne serait une pochette de 200 ml de nectar de mangue. Les coûts additionnels engendrés par cette ligne de conditionnement sont estimés à \$385,000. Le prix au détail du produit est considéré comme le facteur déterminant du succès pour l'usine. Le prix au détail recommandé est de \$0.32/pochette. À ce prix, le produit sera à la porte des consommateurs tout en générant une marge bénéficiaire raisonnable pour l'entreprise. Il est aussi possible de fixer un prix au détail de \$0.21/pochette, mais les marges d'une telle entreprise seraient faibles et le risque de faillite plus élevé.

En conclusion, la ligne de production de purée de mangue couplée avec celle du conditionnement du nectar en pochette est un bon investissement pour le Mali. Le nectar de mangue a des opportunités au niveau des marchés locaux et pourrait certainement pénétrer les marchés de la sous-région.

Chapitre 1 du présent rapport est l'introduction qui fournit la définition de certains termes pertinents pour ce rapport. Chapitre 2 examine le marché mondial de pulpe, de mangue et discute les tendances dans l'approvisionnement et de la demande. Chapitre 3 décrit les opérations de transformation de la

*pulpe, de la mangue et considère le choix de l'équipement. Chapitre 4 expose plusieurs scénarios d'investissement et examine leur faisabilité technique et financière au Mali. Un de ses scénarios considère l'établissement d'une usine de transformation avec une capacité maximale de 2,5 MT de fruits (ff) par heure. Chapitre 5 examine la faisabilité technique et financière de cette entreprise avec l'addition d'une ligne d'emballage du nectar, de mangue en pochettes et le vente national et sous régional. Section 6 résume les conclusions sur le sujet de la production de la pulpe et du nectar de mangue.*

## Executive Summary

This document looks at the feasibility of establishing mango pulp production in Mali. It begins with a brief overview of the international markets for mango pulp. It then describes the processing steps and equipment required to establish a mango pulp production facility and discusses packaging options for both bulk mango pulp and fruit juice nectar in pouches. Finally, it offers a brief financial analysis for both the mango pulp line (including optimistic and pessimistic scenarios) and a mango pulp line coupled with a nectar packaging operation.

The market for mango pulp has been growing steadily since the 1990s and this trend is expected to continue. India is the largest grower of the most widely recognized variety of mango (*Alphonso*) used in pulp manufacture. The country also dominates the world market for mango pulp with over 113,000 MT of production and a 67% share of world exports. The largest share of mango pulp (25%) goes to the Middle East, followed by Southeast Asia and North America. The European Union buys relatively small quantities, just 4% of world exports.

Mangoes are a major crop in Mali – some estimate Mali's mango production at 500,000 MT, albeit much of that total includes less popular varieties of the fruit. There is very little value addition to the mango crop. Mali produces no mango pulp and exports only about 10,000 MT/yr of its fresh mangoes and the prices for fresh mangoes in the local Malian markets during the high season are barely remunerative.

Mango pulp production is possible in Mali. The process is relatively simple, involving seven basic steps; washing, destoning, thermal treatment, homogenization, deaeration, pasteurization and packaging. Packaging is typically done aseptically and the equipment for packaging represents one of the primary investment costs. It is possible to set up a turnkey mango pulp production line in Mali with a 2.5 MT fresh-fruit-per-hour capacity for approximately \$840,000. Such a facility can be profitable and, depending on the raw material costs and the world market prices for mango pulp, can generate annual profits of between \$74,000 and \$242,000.

It is also technically and financial feasible to add a hot fill nectar packaging line to the mango pulp facility. The end product of this line would be 200ml pouches of mango nectar. The additional investment costs for the pouch filling line are estimated at \$385,000. The price point of the product in the local market is seen to be the major determinant of success for the operation. The recommended price point is FCFA 150 (US\$0.32)/pouch. At this price, the product will be accessible to the mass market while also producing a reasonable profit margin for the company. It may be possible to set a FCFA 100 (US\$0.21)/pouch price point, which would be attractive to the Malian consumer, but the margins of such a business would be slim and the risk of failure great.

In conclusion, with the world market for mango pulp is expected to continue its growth and there is an excellent potential nectar market in Mali and the West Africa sub-region. Therefore, the integrated mango pulp and nectar production line is considered a good investment for Mali.

Chapter 1 of this report is an introduction and provides a definition of some of the terms relevant to this report. Chapter 2 examines the world market for mango pulp and discusses trends in supply and demand. Chapter 3 describes mango pulp processing operations and considers choices of equipment. Chapter 4 sets out several investment scenarios and examines their technical and financial feasibility in Mali. One scenario considers the establishment of

mango pulp processing facility with a maximum capacity of a 2.5 MT of fresh fruit (ff) per hour. Chapter 5 looks at the technical and financial feasibility of adding a mango nectar packaging line and the sub regional sales of individually packaged mango nectar pouches. Section 6 summarizes conclusions about the feasibility of Mali's production of both pulp and nectar.

# 1. Introduction

Mali, West Africa, is a major grower of mangoes; its estimated production of fresh mangoes is 500,000 MT/yr. Yet most of the fruit is consumed locally – there is very little value addition to Mali’s mango crop in terms of the production of mango pulp and nectar, despite an expanding world market for pulp and a West Africa market for nectar. This document looks at the feasibility of producing mango pulp and nectar in Mali: it discusses various processing approaches, lays out different scenarios and costs for pulp production and looks at the feasibility of a pulp producer adding a mango nectar packaging line.

## 1.1 Definitions

There is little difference between the terms pulp, puree and juice.<sup>1</sup> The terms pulp and puree are often used interchangeably. Juices is typically used to refer to products where the cell walls of the plant have been largely broken open, giving a clear liquid. A pulp or puree typically has a higher fiber content and considerable plant cellular material in the suspension compared with a “juice”. Juices lend themselves much better to clarification. Fruits that produce purees are; banana, mango, guava, peach and pear. Common juices are apple, grape, orange and grapefruit. Purees, of course, can also be called juices in that they are derived from a single strength pressing of the fruit, with no water or sugar added and the liquid is not concentrated in any way. In this sense, there is no strict distinction between the three terms.

*Concentrated pulp* is a different product. It has more sugar per volume; specifically, regulations state that a concentrate must be at least double the brix<sup>2</sup> of the accepted range of single strength juice, i.e., a minimum 28° brix for mangoes. Most concentrates are 28°–30° brix, whereas single strength mango pulp must be 14°–19° brix.

Mango nectar is defined as the dilution of pure, single strength mango pulp with sugar, water and/or preservatives to make a beverage that has a certain percentage of pure mango pulp/puree. In the US and UK markets, regulations state that mango nectar must have at least 25% pure mango pulp. According to the *Codex Alimentarius*, the actual percentage of pure juice product in the beverage must be noted on the label: i.e. “this nectar contains at least 30% pure mango pulp.”

Mango “drink” is another category of beverage made from mango pulp. In the United States, no beverage with less than 25% pure mango juice content can be termed mango nectar; if such a beverage is labeled with the term “mango,” it must be called mango “drink.” Typically drinks have a very high artificial sugar content and very little real fruit juice.

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<sup>1</sup> In this document the terms mango pulp and mango puree are used interchangeably.

<sup>2</sup> Degrees brix is a measurement of the dissolved sugar-to-water mass ratio of a liquid. It is measured with a saccharimeter or more easily with a refractometer, which measure specific gravity of a liquid. A 25° brix solution is 25% sugar-to-water, i.e., 25 grams of sucrose sugar per 100 grams of solution, or, to put it another way, There are 25 grams of sugar and 75 grams of water in the 100 grams of solution. <http://en.wikipedia.org/wiki/Brix>. Brix in this document is not corrected for acidity.

## 2. The Market and Marketing of Mango Pulp

### 2.1 Usage

Mango pulp is used as a food ingredient, primarily for juice and nectar manufacturers, but also in dairy and bakery products. Mango pulp is gaining in popularity in western markets simply by virtue of the fact that more and more consumers are buying fresh mango fruit and are becoming familiar with its taste. The US juice market now consistently uses mango pulp in its orange juice blends.

As discussed in the preceding chapter, single strength mango pulp has a natural brix of between 14° and 19°; this is relatively high compared with other juices (Table I). The pulp, however, is not highly prized as a 'sugar carrier', even as a concentrate (28°–32° brix), because the raw material cost are relatively high – the price of mango concentrate depends on the variety of mango from which it is derived, but is typically more than \$1000 MT. There are much cheaper 'sugar carriers', such as apple juice concentrates (80° brix) that sell for about \$750<sup>3</sup>/MT and orange juice concentrates for \$950/MT. Therefore, mango is used instead in blends primarily because of its flavor and 'tropical' or 'exotic' connotation.

#### Box I. West African Supply

There is apparently some limited capacity to produce mango pulp in the West African sub-region. In conversations with the equipment maker, Bertuzzi, they confirm having installed processing lines in Benin, Ghana (multiple lines) and Guinea, but we have no information as to the productivity of these lines at this time.

Figure I. Brix Values of Single Strength Fruit Juices

Single Strength Juice Brix Values of Some Common Fruits	
Fruits	Brix
Apple	10.5
Apricot	11.0
Grape	13.0
Grapefruit	9.5
Guava (puree)	8.5
Lemon	7.5
Mandarine/Tangarine	10.5
Mango	15.0
Orange	10.0
Passion Fruit	12.5
Peach (puree)	12.0
Pear (puree)	12.0
Pineapple	9.5

*From Shachman, 2005.*

<sup>3</sup> Currency exchange rates throughout this document are \$1 = FCFA 480, \$1 = €0.73.

## 2.2 Supply

Much of the mango pulp market historically relied on supply from India. Bankruptcies in the industry have caused Indian supply to decline slightly, but today India still holds 67% of the market, producing 113,000 MT/year, primarily from the most widely recognized variety of mango (*Alphonso*) used in pulp manufacture. India is the major supplier to the Asian and Middle Eastern markets; the latter region is the world's largest purchaser of mangoes, buying 25% of world exports. Southeast Asia is the world's second largest market. Thailand and the Philippines share the supply of the Asian market with India. Among other major producing countries are Mexico, Colombia, the Philippines and Brazil. Mexico and Colombia are the major suppliers for the US market. Table 2 profiles world supply of mango pulp/puree in 2003 and estimates supply in 2008.

Table 2. Global Suppliers of Mango Puree/Concentrate, 2003 and 2008

GLOBAL SUPPLY OF MANGO PUREE/CONCENTRATE					
(tonnes)	2003 production	Net exports	% of world	2008* exports	Export growth %
India	117,990	97,990	62.68%	137,200	8
Mexico	26,000	15,765	10.08%	19,700	5
Colombia	22,000	11,800	7.55%	14,750	5
Egypt	16,303	8,459	5.41%	8,450	0
Thailand	13,125	7,380	4.72%	7,380	0
Peru	5,700	5,130	3.28%	5,130	0
Philippines	20,000	4,000	2.56%	4,000	0
Pakistan	15,540	3,000	1.92%	3,000	0
Ecuador	3,000	2,320	1.48%	2,900	5
Brazil	8,813	500	0.32%	625	5
Total	248,471	156,344		203,135	

Source: PARNAV International from PAMCO, Pakistan

\* Estimated

The potential production of mango pulp from Mali in the next 3–4 years could only be a small percentage of world volume, no more than 15,000 MT, or less than 15% of India's total production. This estimate is based on establishment of three mango pulp facilities; two with an annual capacity of 2500 MT/yr (*SudAgri* and *Yaffa et Freres*) and one (*Comafruit*) at 10,000 MT/yr. This estimate is optimistic, as the design and construction of all three facilities has only just begun.

## 2.3 Demand

Mangoes are rapidly becoming a mainstream fruit. As evidence, the world export of mangoes more than doubled between 1996 and 2005, going from 397,000 MT to 826,000 MT. The International Trade Commission estimates the world demand for mango pulp in 2008 at 383,000 MT (Table 3), an increase in demand of almost 40% since 2003! For mango pulp producers, this trend in mango pulp consumption is encouraging.

Table 3. Global Demand for Mango Pulp/Concentrate, 2003 and 2008

GLOBAL DEMAND FOR MANGO PUREE/CONCENTRATE				
(tonnes)	2003	% of	Growthrate	2008*
	demand	world	%	demand
Middle East	69,364	25.1	0	69,400
South-east Asia	56,825	20.56	12	84,520
North America	39,301	14.22	8	55,000
South Asia	38,004	13.75	15	66,500
Africa	30,913	11.19	12	49,500
South America	21,724	7.86	10	32,600
EU	12,975	4.7	5	16,200
Oceania	2,353	0.85	5	3,000
Far East	2,157	0.78	5	2,700
Europe (non-EU)	1,394	0.5	5	1,800
Central America	1,234	0.45	10	1,800
Total	276,310	100	8**	383,020

Source: PARNAV International from PAMCO, Pakistan

\* Estimated

*This [mango pulp] is the product where absolutely all our sources are of the opinion that it is, by far, the best and fastest growing tropical juice. (ITC, 2003)*

More evidence of mango fruit's increasing popularity is seen in the United States. One of the most widely consumed juices in the US is orange juice. Producers in the US are increasingly blending orange juice with small quantities of other juices, mango being one of the preferred because its natural sweetness balances the acidity in orange juice. The annual demand for orange juice by US consumers is considerable, 500,000 MT. Assuming that just 15% of that amount is mixed with mango pulp and that the blend is made with 10% mango pulp, the estimated needs for mango pulp in the US orange juice market niche alone would be 7500 MT/year. If trends in mango consumption such as these continue, then it is reasonable to expect the world demand for mango pulp will continue to grow.

The US market, however; is probably not the target market for Malian mango pulp. Two related factors preclude Mali from capturing much of the US market: First, transport is at least 15% of the cost of bulk mango pulp and this cost center must be managed closely by mango pulp traders. This alone could exclude the Malian producers from the US mango pulp market since the extra shipping costs would reduce the already narrow margins gained on this product and make the Malian producers uncompetitive with the Mexican and Columbian producers. Additionally, as noted above, Mexico's (and Colombia's) long-standing market position, their massive volumes and relative proximity to the US market make it likely that they will remain the primary suppliers to the US market.

The closest market to Mali is the European Union (EU). The EU market for mango pulp, however, is only 4.7% of world exports, probably because mango is not a traditional juice in Europe. While a recent upward trend in fresh mango imports to the EU bodes well for mango pulp's long-term future in this market, the near-term prospects for the Malian product finding an entry to the market are minimal unless the Malian product develops some distinct competitive advantage.

### **Can Mali compete on price?**

Without real production figures, it is difficult to predict how Mali could compete on price, but in benchmarking the projected Malian production against that of India, the two countries' cost structure is similar, with the Malian product showing no considerable advantage. The average estimated cost of the Malian raw material as a percentage of the total FOB sale price of the pulp is estimated to be 23%, whereas it is 26% for the Indian pulp<sup>4</sup>. Labor costs in Mali may be slightly less, but this would be counterbalanced by the relatively high energy costs. This indicates that Mali would be hard pressed to capture any market share away from India, and thus should probably concentrate on markets where India is not present and where Mali has some type of competitive advantage. The proximity of Mali to the EU makes this market the most attractive.

The EU is geographically situated in a way that makes import from both Asia and South America equally feasible – they currently ship mangoes from suppliers in both continents. With shipping costs such a large part of the mango pulp price, the fact that the EU is distant from both of its current sources of supply may explain why the consumption in the EU market is relatively low – other juices may enter the EU market more cheaply, like apple juice from Poland. Due to its proximity the EU market would seem to be the natural destination for Malian product. Furthermore, it is possible to believe that demand could grow in conjunction with a reliable, relatively low-cost supply from Africa. This is only speculation, however, in the absence of real data about the EU marketplace and a multi-year view of trends in sales.

### **Can Mali compete on quality?**

The qualities and specifications of Malian mango pulp are unknown at this time. The tendency in the industry is to rely on known flavors and varieties. That is why the Alphonso mango, with its characteristic taste and best pulp quality of any mango variety produced in considerable quantity, is so popular today. Most processors know its qualities and are used to working it into their blends. They have no surprises with this variety.

In contrast, the mango varieties grown in Mali – primarily Amélie, Kent, Kiett and Palmer – are less prevalent in the pulp market. They may be found to have some unique flavor profiles that give them an advantage in niche markets, but it is unlikely that the Malian producers, with a pulp of untested quality and/or minor presence in the marketplace, would have an immediate competitive advantage in terms of quality in the EU marketplace. Introducing mango pulp made from uncommon varieties is a hurdle that Malian producers must overcome, making their investments all the more risky and something for potential processors to carefully consider.

## **2.4 Prices**

The prices of mango pulp fluctuate by variety, by time of the year and from year to year. The market price is highly dependent upon the farm gate price of fresh mangoes, which largely depends on the size of the yearly crop. Crop size varies wildly from year to year, often affected

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<sup>4</sup> Note there is wide variation in these figures (16%–41%), depending on variety, year and season.

by storms or unusual weather patterns. It is therefore difficult to predict the price of mango pulp prior to the approaching season.

Further complicating the situation is the fact that Malian mango pulp will be made from lesser known varieties for which relatively little data exists. Mexico produces some of its mango pulp using the Kent variety, which also exists in Mali. The price of Kent pulp may be the best proxy for the price of all Malian mango pulp. However, pulp made from varieties like Kent are such a small part of the pulp market, we still have very little data on their price trends and will have difficulty estimating the potential value of Malian-produced pulp. We do know, however; the world price of mango pulp from the Kent variety was \$775/MT in 2003, whereas the average price of the popular Alphonso in that same year was \$975/MT; 20% more than Kent pulp. The price for the Alphonso variety is well documented, so a good pricing benchmark may be to use the price of Alphonso to estimate a price for Malian mango pulp; which will always be 20% less than the price of Alphonso in any given year. Table 4 also offers another set of price figures to guide the Malian investor.

Table 4. World Prices of Mango Pulp, 2004

2004						
Country	Mango Type	Product	Brix	Amount	Freight	Port
Peru	Chato de Ica	frozen puree	15-17 Brix	US\$1050/mt	fca	Europe
Peru	Chato de Ica	frozen puree	15-17 Brix	US\$1000/mt	fot	Rott
India	Alfonso	aseptic puree	16 brix	US\$1550-1580/mt	fot	Rott (Duty Unpaid)
India	Kesar	aseptic puree	16 brix	US\$1250-1275/mt	fot	Rott (Duty Unpaid)
India	Totapuri	aseptic puree	14 brix	US\$850-75/mt	fot	Rott (Duty Unpaid)
India	Totapuri	aseptic conc	28 brix	US\$950-975	fot	Rott (Duty Unpaid)
Brazil	Palmer	aseptic puree	16 brix	US\$850/mt	fot	Rott (Duty Unpaid)
Brazil	Tommy Atkins	aseptic/frozen conc	28-30 brix	US\$800	FOB	
Brazil	Palmer	aseptic/frozen conc	28-30 brix	US\$800/mt	FOB	
Pakistan	Chaunsa	ss puree	22-25 brix	US\$1180/mt 5kg drums	fca	Holland
Pakistan	Daisy	ss puree	15-18 brix	US\$800/mt 5kg drums	fca	Holland
Mexico	Tommy Atkins	frozen puree		US\$1000/mt DDP	fot	Main USA port

Source: [http://www.intracen.org/mds/sectors/fruitveg/fj\\_rep04.pdf](http://www.intracen.org/mds/sectors/fruitveg/fj_rep04.pdf) (ITC)

### 3. Processing Mango Pulp

This chapter describes the process for producing a single strength mango pulp. The product will be made from the predominant Malian varieties of mango; Kent, Kiett, Amélie and Palmer. The target brix will be 17°. The acceptable range for a single strength mango pulp is 14°–19° brix.

#### 3.1 Raw Material Supply

The estimated production of fresh mangoes in Mali is 500,000 MT. The major production regions are the southwestern portion of the country: the Bamako area, Sikasso and Koulikoro. The entrepreneurs who propose the establishment of mango processing facilities in Mali intend to obtain their raw material either from Sikasso or Bamako.

Sikasso is the biggest mango production region in the country, with an estimated production at ~204,000 MT/yr. Statistics from Sikasso indicate that about 50% or more of this production is

from the desired varieties of mangoes for pulp production (Table 5). The other 50% is made up of the fibrous local variety, known as *Mangou*, and other lesser-known varieties.

Table 5. Estimated Mango Production in Sikasso, by Variety

<b>Estimated Mango Production in Sikasso</b>			
<b>Variety</b>	<b>Volumes</b>	<b>% Total</b>	<b>Period of Harvest</b>
<i>Mangou (local)</i>	~87,500	44%	1 April – 30 April
Amélie	46,707	23%	15 April – 15 May
Kent	29,751	14%	15 May – 15 June
Kiett	24,941	12%	30 June – 30 July
Palmer and others	~15,000	7%	Mostly May - June

### 3.2 Concentrated Mango Pulp or Single Strength Mango Pulp?

Before describing the processing steps, a discussion is offered concerning the choice between producing single strength pulp or mango pulp concentrate.

Concentrated mango pulp is a common and popular product, and is commercially sold in volumes similar to many of the same types of clients who buy single strength juice. Concentrates are often stored and shipped in frozen form. Concentrates are a good economical choice in scenarios where shipping distances are long; however, they are a bad economical choice where energy costs are high, as is the case for Mali. Producing a concentrated juice product requires evaporation and/or freezing, which are both energy-intensive processes. If the Malian manufacturers want to target the relatively close-by European market, producing single strength pulp is most likely their best option. This will keep energy costs at a minimum and will represent the lowest initial capital investment. Also, both concentration processes have detrimental effects on the aromatic profile of the product (see comparison of these processes in next section).

Finally, another argument for using single strength juice is the rising popularity of the label designation NFC (not from concentrate). This designation is used to specify a product that has undergone minimal processing and is attractive to consumers wanting a more 'natural' product.

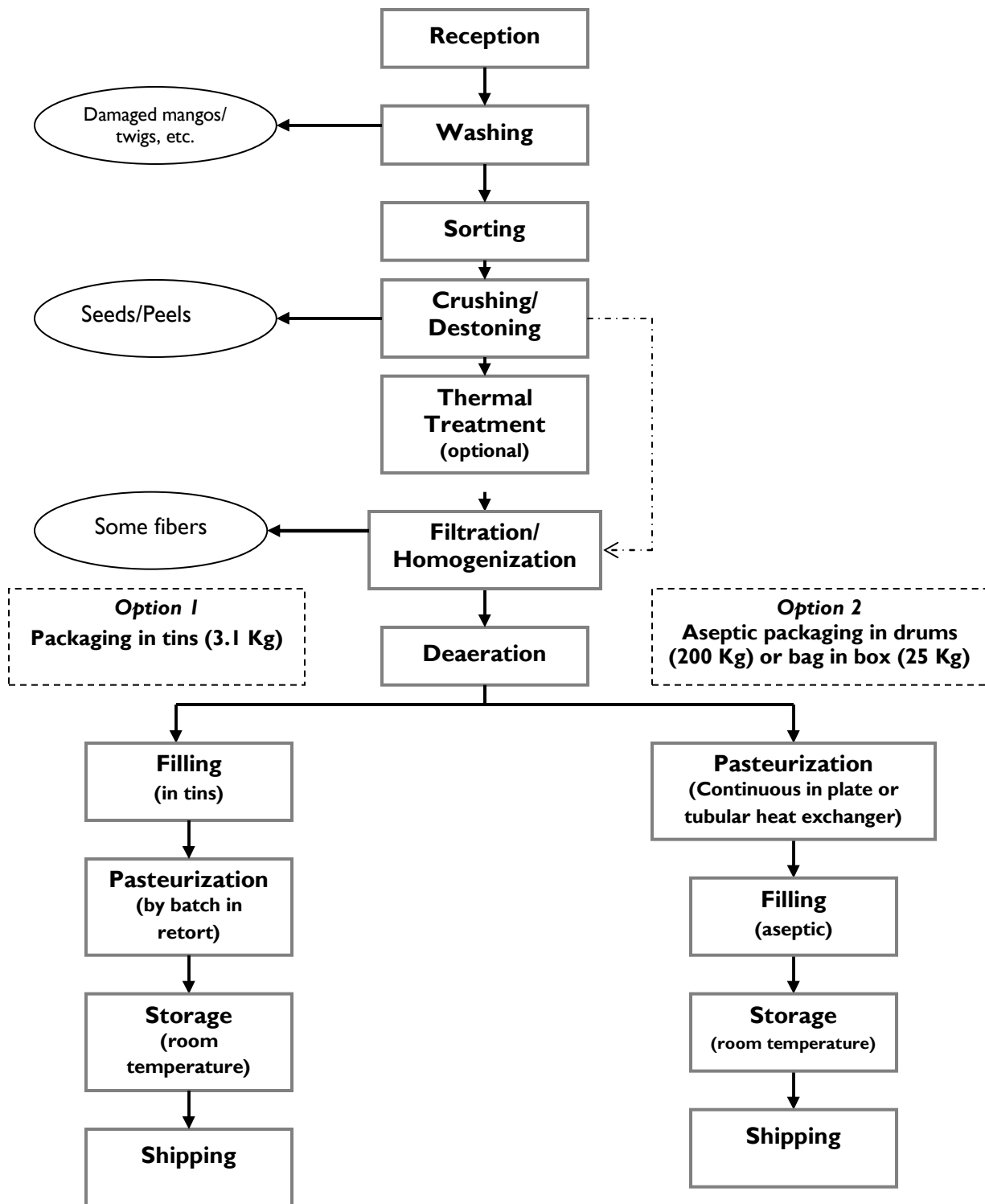
We do not have precise data at this time comparing the relative energy costs and investment costs of freeze concentration to the production of single strength juices, but since the single strength technology is relatively more accessible, cheaper and has lower energy requirements, it is assumed to be the right choice at this time for Malian producers of mango pulp. Concentration is a step that can be added later if transportation cost of single strength juice becomes prohibitive or if the market demands concentrate.

The choice to produce concentrate as opposed to single strength juice would introduce a much greater degree of technical complexity and initial investment costs. The Malian processors should therefore consider this as an option only if transport becomes the most limiting factor in the competitiveness of their products. The price premium for mango concentrate by itself is only about 10% above single strength pulp.

### **3.3 Unitary Operations in Processing Mango Pulp**

The following description of the processing steps involved in the production of single strength mango pulp is for a smaller-scale facility that would typically process 2–8 MT ff/hour. Some of the optional processes, with their advantages and disadvantages, are also discussed. A flow chart is provided in Figure 1.

**Figure 1. Processing Flow Chart  
Mango Pulp Production (single strength)**



### Reception/Maturation

Any facility working at full capacity should work on a three-shift, 24-hour schedule. This limits the amount of set-up and tear-down time needed for cleaning. Certainly there should be a regular maintenance and cleaning schedule, but with a continuous process it may not be necessary to clean on a daily schedule. Once the equipment choice is made, the proper shift schedule can be determined. The Bertuzzi system (see below) use CIP (cleaning in place) and thus minimizes the amount of plant down time.

At full capacity, a facility processing 2.5 MT of ff/hour will process 60 MT of mangoes daily. The actual reception area should be much larger, as mangoes will be delivered in all stages of ripeness and may require up to 7-10 days of ripening prior to processing. Mangoes should be stored in the shade and not in direct contact with the soil. A pavilion with a concrete floor may be the best solution for Mali. However; there are other modifications that can be made to augment the speed and the evenness of the ripening. The lowest cost solution is to store the mangoes in boxes (wood, plastic or cardboard) and cover them with a layer of straw and then a layer of newspaper. This arrangement allows the mangoes to respire, while also trapping the natural ethylene given off by the mangoes to speed ripening. Another option is to introduce ethylene gas artificially into a closed chamber. These types of storage areas are typically sealed hermetically to conserve the gas (the one in Image 1 is lined with black plastic to trap the ethylene).

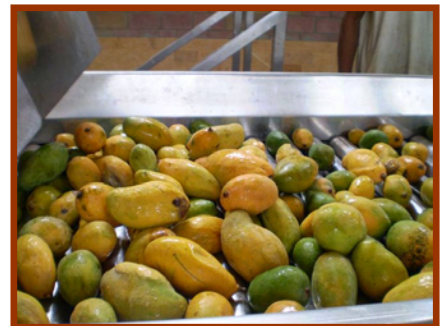
The total storage area required to hold just 7 days worth of production is about 800m<sup>3</sup>.

### Washing / Sorting

The vast majority of dirt and potential microbial contamination is found on the skin of the mangoes because of their contact with multiple surfaces during harvest and transport. One of the greatest gains in reducing the microbial load is, thus, achieved by the initial wash. This wash should be done in warm water (Image 2). Mangoes destined for the fresh market can be washed in chlorine or peroxyacetic acid (both FDA approved) if the end market accepts the use of these chemicals, but mangoes destined for pulp cannot be



**Image 1.** Mango Reception and Ethylene Chamber. *Bangalore, India.*



**Image 2.** Washing mangoes for pulp production. *Bertuzzi.*

washed in chemicals.

The washing is followed by sorting to remove damaged mangoes. Bruised mango flesh has active enzymes and can degrade the final product even in the short time prior to entering the thermal break or the sterilizer, where the enzymes are mostly denatured and deactivated.

### **Crushing and Destoning**

Once washed, the mangoes enter the destoners, specialized drums where they are cut and squeezed using rotating blades that separate the pulp from the seeds and the skin (Image 3). This is the step that generates the most waste and conveyors should be in place to carry the waste out of the factory at this point in the process.

The mango destoner is a somewhat versatile extractor and can also be used to extract juice from other fruits, such as guava and papaya with the addition of different blades and different filtering screens.

It is possible to opt for a manual removal of the skin and seeds and then feed the mango flesh into an extracting device; either a mixer or press that is even more versatile in the types of fruits it can accommodate. Using this option may be best if mango fruit were to be only a portion of the types of fruit juice produced at the facility. It is estimated; however; that 66 additional employees would be required to conduct the manual peeling and destoning operation for a 2.5 MT ff/h facility [This assumes an experienced operator can separate mango flesh from the skin and seed of a 200g mango in 20 seconds].

### **Thermal treatment**

The thermal treatment prior to extraction in the super creamer is designed to soften the fruit and increase the yield of pulp from the fruit. This treatment, however, is considered optional. The trend in the industry today is to skip the thermal treatment prior to extraction as it leads to only a 3% increase in yield of pulp from the raw material. Also, if used, this treatment must be closely monitored so that it does not induce a browning of the pulp.

If the thermal treatment is used, it is done inside a steam-filled chamber (Image 4). The mango pulp passes through this chamber and is heated to about 90°C. The thermal treatment, in spite of the risk of browning via maillard



**Image 3.** Mango destoners.  
*IAC Pakistan.*

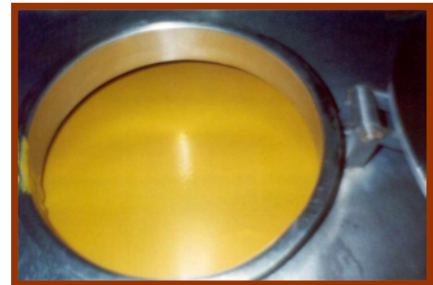


**Image 4.** Thermal break. *Bertuzzi.*

reactions, has the advantage denaturing enzymes that cause chemical degradation of the mango pulp. The thermal treatment, therefore, has both advantages and disadvantages and the question of whether to use it is up to the owner of the facility. The owner must take into consideration the projected needs and desires of his buyers and the costs of the raw material. If raw material is cheap and plentiful, a 2-3% yield increase may not be worth the added risk, investment and running costs. In today's quality-conscious market, it is considered best to sacrifice a little yield in order to preserve product quality.

### **Creaming / Filtering**

After the thermal treatment, the pulp is held in a mixing tank and then sent to the super creamer (Image 5). The super creamer homogenizes the product by passing it through two screens of different size mesh, 3mm and then 1.5mm. Creaming homogenizes the product and removes any remaining fibers.



**Image 5.** Creamed mango pulp.  
*Bertuzzi*

### **Deaeration**

The preceding steps add considerable air to the product. This extra air makes the product much more susceptible to oxidation, which leads to browning and increased acidity. To prevent oxidation, air can be removed in a deaeration chamber, which places the product under vacuum for a short period of time (Image 6). This step is often skipped in most Indian operations.

### **Pasteurization/Sterilization**

The goal of pasteurization (sterilization) is to bring the microbial load down to a level that will not induce damaging bacterial or fungus growth in the product at any point in its future life. Thus, products destined for different uses are in theory eligible for different degrees of pasteurization. The juice industry has established norms for processed fruit juices and has defined the maximum acceptable levels of microbial load for products. For example, a product destined for immediate consumption would need a very low degree of pasteurization or a light



**Image 6.** Deaerator.  
*IAC Pakistan.*

'kill step,' if any. This is effectively what happens when one buys fresh squeezed fruit juices at a juicing bar. The juice is pressed right in front of the consumer and there is no combination of time and/or exposure to contaminants that would allow harmful levels of microbes to reproduce.

The accepted threshold levels set for the microbial load of mango pulp is quite low; i.e. a very strong kill step is required. As can be seen in the product specification sheet (Annex A), no level of yeast, mold or two specific bacteria types, *E. coli* and *S. aureus*, is acceptable. The total plate count is set below 50 CFU per gram, also low relative to other food products. To achieve this, very high sterilization temperatures are used (105°C).

While these high standards protect consumer safety, they make processing more complicated and costly: a strong, continuous in-line kill step consumes energy, increasing running costs. And, as was discussed in section 3.3, the extreme heat risks degrading the organoleptic qualities of the product – loss of aromas, chemical degradation of vitamins, inversion of sugars and browning. Thus, manufacturers typically try to minimize the time and temperature at which their products are sterilized.

The intensity of the kill step required depends on the initial microbial load of the product. For this reason the initial washing of the product (see above) is critical. As such, in an HACCP design, testing the microbial load of the skins post-washing is a critical control point.

Two types of heat exchangers are used in a continuous juice pasteurization process; tubular and plate. Plate heat exchangers are extremely efficient at heating and cooling the product, but in mango processing, the plates tend to get crusted over with scorched fibers, reducing the heat exchange capacity. Tubular exchangers are recommended in mango pulp processing as the pulp and residual fibers flow through without sticking to the sides of the corrugated tubular surface (Image 8).

An alternative to in-line sterilization is to first fill the product into tins and sterilize the canned product in retorts. This greatly reduces the initial investment costs, as the heat exchangers and the aseptic filler are no longer required. These expensive pieces of equipment are replaced with a lower-cost non-aseptic filling unit and a



**Image 7.** Double tubular pasteurization for mango pulp. *IAC Pakistan.*



**Image 8.** Tubular sterilizer w/ control panel.

retort. Retort sterilization is done in batches and can be much slower than the continuous in-line process, but the capacity can be matched to the production in the facility by duplicating the retorts.

Although the costs of retort sterilization are lower, it is considered an outdated process and product packed in the 3.1 kg tins are viewed as lower quality with a higher food safety risk. Another potential obstacle for Malian processors who want to package in tins is finding a source of supply for the tins and the related shipping costs.

To reduce the cost of aseptic filling, Bertuzzi has an optional, lower-volume aseptic filling machine (1000 l/h), which may bring the filling rate slightly below the stated capacity of the production line of 2.5MT ff/h. Although this would limit future increases in capacity, it may be the only option if investment costs are a major concern.

It should be noted that both the high- and low-volume aseptic fillers can fill both bag-in-box or bag-in-drum packaging (see Packaging, below), the low-volume filler just works much more slowly.

### Packaging

Malian producers should seek to export mango pulp in bulk containers, as it is the most suitable for reception at industrial facilities. There are three bulk packaging options: bag-in-box, bag-in-drum or tins. The first two aseptic packaging types are acceptable by industry standards, although certain buyers may prefer one over the other. Most large-scale processors prefer the drums, which require fewer steps for transfer of the pulp to their tanks; the operator inserts the vacuum hose only once per 210 liters as opposed to 16 times for the same amount of bag-in-box-packaged pulp (25 kg boxes containing two 12.5 kg bags).

Luca Panzeri of Bertuzzi claims that the smaller aseptic bag-in-box product is an interesting market niche that could provide a competitive advantage, since the industry is replete with product in 220-liter drums, a volume too large for processors such as small bakeries or ice cream manufacturers.

The third, and lowest-cost packaging option is tins (Image 10). This option may be good if Malian producers target lower-end markets, or if much of the pulp will be stored within Mali for use in juice-making at the same facility.



**Image 9.** Aseptic packaging at 6000l/h. Bag in drum. SFA Pakistan.



**Image 9.** Mango pulp in tins.

## 4. Equipment Cost of Pulp Production

Three quotes were examined for mango pulp processing lines at the stated capacity of 2.5 - 3.0 MT/hour. The first quote was from Bertuzzi, an Italian manufacturer that is one of the predominant suppliers in the industry. They even install equipment in India, despite the existence of numerous Indian equipment manufacturers. Their line calls for an in-line tubular sterilization process with aseptic filling. Their estimate was for \$852,000 (€600,000), not including the cost of the thermal break as this is considered optional.

The second quote was from Process Masters in India. For the stated capacity, they suggested a mango processing line that packages the product in tins, claiming that a positive return on investment cannot be achieved for aseptic filling unless the pulp production capacity exceeds 4 MT/h, or 8 MT of ff/h. The canning line would use a simple volumetric filling machine (non-aseptic) and batch sterilization in a retort. Its cost, \$252,510, is much less than the line proposed by Bertuzzi. (See Figure 2 for the itemized Process Masters quote.)

Process Masters also provided a quote for a processing line that would use a tube-in-tube sterilization system with aseptic filling. The quote, minus the cost of the aseptic filling line, was \$171,418. This quote is less than the one seen in Figure 2 because they removed the retort, can reforming unit and seamer. Process Masters does not make aseptic filling equipment; if they were to obtain it from another manufacturer, it would cost an additional \$350,000<sup>5</sup>.

Thus, for a mango pulp production facility with aseptic filling, the cost will be between \$521,000 and \$850,000. The investment costs for a canning facility and simple batch sterilization are obviously much less, but the disadvantages of producing such a product, as discussed above in the packaging section, greatly limits the potential market.

It should be noted that neither of the quotes for the aseptic processing include the plant and utilities; steam, electricity, water and compressed air. In order to make a quick estimate, however, the industry standard for food processing is to take the equipment costs at about 65% of the total cost of plant installation. Applying this rule of thumb to the above quotes would bring the cost of the Bertuzzi-equipped plant to \$1.3 million (\$852,000 for the processing line, \$448K for the plant and utilities). The Process Master's plant with aseptic processing would cost about \$800,000 (\$171,000 for the processing line, \$350,000 for the aseptic filling equipment, \$280K for the plant and utilities).

Since either facility would require a similar plant design and utilities, a middle-of-the-road estimate (about \$300,000) for the overall plant and utilities investment was used consistently throughout all of the financial analysis scenarios. If the Process Master's equipment is used, the estimated investment costs for a 2.5 MT ff/h plant would be \$820,000 (FCFA 393,600,000).

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<sup>5</sup> The Process Masters claim, however, that it is impossible to get a return on investment for an aseptic filling equipment unless the facility produces pulp at a rate of 4.0 MT/h.

**Figure 2. Process Masters Quote for 2.5 MT/h Canning Line with Retort Sterilization**

<b><u>SCHEDULE OF PRICES :-</u></b>			
a) Design, Detailed engineering, fabrication, assembly & supply of processing line as per above mentioned list –			
<b>Sr No</b>	<b>Particulars</b>	<b>Qty required</b>	<b>PRICE Total FOB Mumbai US \$</b>
1.	Fruit and Vegetable Washer	1 No	22800
2.	Inspection Conveyor	1 No	20000
3.	Bucket Elevator	1 No	5800
4.	Mango De-stonner	1 No	13700
5.	Rectangular tank 500 ltrs	1 No	1300
6.	Screw Pump	1 No	3000
7.	Mango pulp pre-heater	1 No	8300
8.	Pulping unit twin type	1 No	12500
9.	Rectangular tank 500 ltrs	1 No	1300
10.	Screw pump	1 No	3000
11.	Mixing tanks 1500 ltrs	2 Nos	11600
12.	Screw Pump	1 No	3000
13.	De-aeration system	1 Set	19000
14.	Pasteurization system	1 Set	30800
15.	Empty can washer	1 No	5800
16.	Rotary Can filler	1 No	15750
17.	Discharge conveyor	1 No	2900
18.	Seamer	1 No	10000
19.	Vertical retort	4 Nos	13300
20.	Can reforming section	1 Set	11620
21.	Steam jacketed kettle 250 ltrs	1 No	2300
22.	Product piping and fittings	1 Set	11400
23.	MS structures	1 Set	8500
24.	Waste handling system	1 Set	14840
	<b>TOTAL</b>		<b>252510</b>
<b>( US\$ Two Hundred and Fifty Two Thousand Fie Hundred and Ten Only )</b>			

Note that “Five” is misspelled as “Fie”.

## 5. Preliminary Financial Feasibility

The following is a financial analysis to test the feasibility of setting up a mango pulp processing facility in Mali. It is difficult to put an exact figure on some of the more important variables, like raw material price and the price of pulp on the world market, as they vary with supply season to season. These variables and the sources of their estimates are discussed below.

### 5.1 Raw Material Costs

Mangoes are said to be worth ‘nothing’ during the height of the mango season. Indeed, a visitor to any village in the Sikasso region during the months of May and June is likely to be loaded down with free mangoes when departing from the village.

By contrast, exporters in the Sikasso and Bamako regions pay from FCFA 60 (\$ 0.13) to FCFA 90 (\$ 0.19) per kilo for mangoes delivered to the packing-house door. Of course, mangoes destined for export, especially those that will be shipped by sea, must be selected carefully. There is a very narrow window of time during which they can be harvested, and they must be under-ripe. As such, considerable sorting takes place at the village level. Also, mangoes for export are typically shipped in single-variety loads. This requires additional sorting. It is these factors that contribute to the much higher cost of mangoes destined for export.

Unlike mangoes for export, those used for pulp production should be picked at the latest possible date, at a very advanced state of maturity so that the sugar content is high, but they should show no signs of browning or decay. Theoretically, a mango pulp factory could absorb any mangoes received at a packing-house that are found to be too ripe for export. In fact, combining the sorting operations could engender some synergies and cost savings<sup>6</sup>. However, pulp production-only factories must avoid accepting mangoes from collectors who are not skilled at identifying fruit at the proper state of ripeness. Under-ripe mangoes must be allowed to ripen for a few days before processing, requiring the facility to bear the extra cost of storing and managing large quantities of unripe fruit.

Under any scenario, the price of mangoes destined for pulp production should be less than that of those destined for export given the more flexible and broad criteria for their collection and delivery (Image K).



**Image K.** Mango ripening at reception.

The potential investors in pulp production in the Bamako area believe that they can have mangoes delivered to their facility for FCFA 60/kg (\$0.13) or less. The potential producers in Sikasso claim that they can easily have mangoes all season long at FCFA 20/kg (0.04/kg). This is

<sup>6</sup> Bakary Yaffa, one of the potential Malian mango pulp producers, already has an export business.

quite a discrepancy in price and makes the estimate of the financial viability for a Malian facility more difficult to discern. Therefore, two estimates of financial viability were made, one using FCFA 40 /kg (\$0.08/kg) and the other FCFA 60/kg (\$0.13/kg).

## 5.2 Price for Pulp

The price determination for mango pulp was discussed above. Based that discussion and conversations with India mango pulp producers in September of 2009 who claim that Alphonso pulp is selling for nearly \$1100/MT, assuming that Alphonso is 20% more expensive than the Malian mango pulp, we estimate the value of Malian mango pulp at \$910/MT FOB. A buyer in the United Kingdom in August 2009, however; stated that the price for mango pulp was only \$600-\$700/MT FOB. We will use the information from both of these sources to create two pricing scenarios, one optimistic and the other pessimistic. Reliable pricing information is difficult to obtain due to the hedging of the responses from both the buyers and the sellers.

### Cost Analysis

The tables (6-9) in this section itemize the cost of mango pulp by major cost centers using estimates obtained from the literature and contacts in the industry. The tables also provide an indication of likely profit margins.

In the optimistic scenario, the price of the raw material is set at FCFA 40/kg (\$0.08/kg) and the sale price of the pulp is set at \$910/MT FOB Mali (Table 6). In the pessimistic scenario, the cost of the raw material is FCFA 60 /kg (\$0.13) and the sale price of the pulp is \$700/MT FOB Mali (Table 6).

Table 6. Cost Analysis Scenarios

<b>Variable</b>	<b>Optimistic</b>	<b>Pessimistic</b>
Raw material cost (FCFA/kg) (US\$ equivalent)	FCFA 40/kg (US\$ equivalent)	FCFA 60 /kg (US\$ equivalent)
Sale price mango pulp (\$/MT FOB Mali)	\$910/MT	\$700/MT

The analysis below illustrates quite clearly that the cost of raw materials is one of the major cost centers and represents between 18% and 35% of the final sale price of the product. Another major cost center is the packaging of the final product. The product is packaged in 210 liter aseptic bags that serve as inserts into the 220 liter steel drums. The cost of the bags is estimated at \$35/pc delivered and the drums at about \$15/pc obtained locally. The packaging thus costs \$0.24/kg and represents about 26% - 34% of the cost of the final product.

The aseptic bags are made primarily by European suppliers, which accounts for their high price. A factory in Chennai, India, has started manufacturing these bags and the cost is reported to be considerably less, but it was not possible to obtain a quote for this analysis. As packaging is such an important cost center, any investor should strive to obtain these bags at the best price. This will likely entail buying in bulk for the entire year and therefore the final financial analysis will have to take into account financing for the purchase of these bags before the season begins. This was not done in this analysis and thus the working capital financing cost may be underestimated here.

In this analysis, the company can be profitable under either scenario. The estimated profit margin is 43% under the optimistic scenario and at 13% under the pessimistic scenario.

**Table 7. Cost Analysis of Mango Pulp Production in Mali: Optimistic Pricing Scenario**

				Variables	
<b>Average Annual Production</b>	<b>2500</b>			Pulp production/yr	2500
	<b>Cost / Kg Pulp (FCFA)</b>	<b>% of FOB Price</b>	<b>Notes</b>	Exchange Rate (FCFA/\$)	480
<b>Price Pulp FOB Mali</b>	<b>437</b>	<b>100%</b>		Price FOB Mali (\$/MT)	\$ 910
Raw Material	80	18.3%	Average delivery price to factory door. Raw material needs are twice the output in final product.	Days of operation/yr	100
Equipment Ammortization	16	3.6%	Equipment depreciated linearly over 12 years.	Shifts	3
Financing Equipment	7	1.6%	Cost to finance 50% of the investment at 12% over 5 years. Capital paid at 20%/year	Daily labor salary	3000
Financing Working Capital	5	1.1%	Annual raw material needs financed over 6 months each year.	Laborers/shift	30
Labor	11	2.5%	3000 FCFA/day * 30 persons *100days * 3 shifts/d divided by MT pulp/yr	Yield pulp per mango	50%
Energy	8	1.8%	8 FCFA per kg mango pulp	Investments	393,600,000
Packaging	114	26.2%	24,000 FCFA / 210L aseptic bag + barrel.	Raw material cost/kg	40
Marketing	11	2.4%	Salary + Trade Fair + Printed Materials	Working capital needs/mo	50,000,000
<i>Sub Total</i>	<b>251</b>	<b>57.5%</b>		Marketing	26,400,000
<b>Profit Margin</b>	<b>186</b>	<b>42.5%</b>		Interest Rate (Investments)	15%
				Interest Rate (working capital loan)	12%

**Table 8. Cost Analysis of Mango Pulp Production in Mali: Pessimistic Pricing Scenario**

				Variables	
<b>Average Annual Production</b>	<b>2500</b>			Pulp production/yr	2500
	<b>Cost / Kg Pulp (FCFA)</b>	<b>% of FOB Price</b>	<b>Notes</b>	Exchange Rate (FCFA/\$)	480
<b>Price Pulp FOB Mali</b>	<b>336</b>	<b>100%</b>		Price FOB Mali (\$/MT)	\$ 700
Raw Material	120	35.7%	Average delivery price to factory door. Raw material needs are twice the output in final product.	Days of operation/yr	100
Equipment Ammortization	16	4.7%	Equipment depreciated linearly over 12 years.	Shifts	3
Financing Equipment	7	2.1%	Cost to finance 50% of the investment at 12% over 5 years. Capital paid at 20%/year	Daily labor salary	3000
Financing Working Capital	7	2.1%	Annual raw material needs financed over 6 months each year.	Laborers/shift	30
Labor	11	3.2%	3000 FCFA/day * 30 persons * 100days * 3 shifts/d divided by MT pulp/yr	Yield pulp per mango	50%
Energy	8	2.4%	8 FCFA per kg mango pulp	Investments	393,600,000
Packaging	114	34.0%	24,000 FCFA / 210L aseptic bag + barrel.	Raw material cost/kg	60
Marketing	11	3.1%	Salary + Trade Fair + Printed Materials	Working capital needs/mo	75,000,000
<b>Sub Total</b>	<b>294</b>	<b>87.4%</b>		Marketing	26,400,000
<b>Profit Margin</b>	<b>42</b>	<b>12.6%</b>		Interest Rate (Investments)	15%
				Interest Rate (working capital loan)	12%

Annual production volume is another variable that will have an impact on profitability. The above scenarios estimate that the company will produce 2500 MT of pulp annually. This total is based on 100 days of production at 2.5 MT ff/h for 20 hours per day. This is a full production schedule and there are many scenarios under which this level of production might not be maintained throughout the season. The operators must take all precautions to avoid production stoppages, because running under capacity will have a negative impact on company profitability. For example, the break-even point under the pessimistic scenario is 1275 MT of production per year (Table 9), or 51% of the stated capacity. Below those volumes, the company will run at a loss.

**Table 9. Cost Analysis of Mango Pulp Production in Mali: Break-even Point (1275 MT/yr).**

				Variables	
<b>Average Annual Production</b>	<b>1275</b>			Pulp production/yr	1275
	<b>Cost / Kg Pulp (FCFA)</b>	<b>% of FOB Price</b>	<b>Notes</b>	Exchange Rate (FCFA/\$)	480
<b>Price Pulp FOB Mali</b>	<b>336</b>	<b>100%</b>		Price FOB Mali (\$/MT)	\$ 700
Raw Material	120	35.7%	Average delivery price to factory door. Raw material needs are twice the output in final product.	Days of operation/yr	100
Equipment Ammortization	31	9.2%	Equipment depreciated linearly over 12 years.	Shifts	3
Financing Equipment	14	4.1%	Cost to finance 50% of the investment at 12% over 5 years. Capital paid at 20%/year	Daily labor salary	3000
Financing Working Capital	7	2.1%	Annual raw material needs financed over 6 months each year.	Laborers/shift	30
Labor	21	6.3%	3000 FCFA/day * 30 persons * 100days * 3 shifts/d divided by MT pulp/yr	Yield pulp per mango	50%
Energy	8	2.4%	8 FCFA per kg mango pulp	Investments	393,600,000
Packaging	114	34.0%	24,000 FCFA / 210L aseptic bag + barrel.	Raw material cost/kg	60
Marketing	21	6.2%	Salary + Trade Fair + Printed Materials	Working capital needs/mo	38,250,000
<b>Sub Total</b>	<b>336</b>	<b>100.0%</b>		Marketing	26,400,000
<b>Profit Margin</b>	<b>0</b>	<b>0.0%</b>		Interest Rate (Investments)	15%
				Interest Rate (working capital loan)	12%

## 6. Mango Nectar Production

The analysis of mango pulp production assumes that the mango pulp is sold exclusively in the export market. There is, however, considerable demand for juices in Mali. The country's National Bureau of Statistics states that in 2007/08, Mali imported over 2 million liters of juice<sup>7</sup>. It must be noted that this figure represents declared imports and is likely to be appreciably less than the actual figure.

Most of the juice imported by Mali is packaged in 1 liter Tetra Pak Briks, which retail for about FCFA 1200 (\$2.5)/liter. This price is thought to seriously inhibit purchases by the vast majority of Malian consumers, most of who drink juices that are pressed locally in homes and small, artisanal workshops. The quantity of these locally produced juices is entirely unknown, but it can be estimated as several times that of the juices consumed in the Tetra Paks.

Therefore, the best strategy for entering the Malian juice market with an industrially produced product might be to reduce the packaging size and the unit price of the product to match that of the Malian purchasing power. It is this strategy that guides the development of the following scenario.

### 6.1 Processing and Packaging

A mango pulp production facility like one of the aseptic facilities described above would only need to add a packaging line in order to produce a juice/nectar. It might also require a separate pasteurization line, depending on the production schedule and targeted volumes. Such a facility would produce and store its mango pulp in the aseptic drums and use the pulp throughout the year to make mango nectar via the addition of a prescribed amount of water and sugar.

The process of filling juices for individual consumption can be surprisingly complex and costly. Table 10 lists the different packaging options and the pros and cons of using each. This information is based on contact with a limited number of equipment makers (<10) but represents the major categories of equipment and filling processes that are available today.

Two options for juice production appear to be viable for Mali: canning and hot filling. These are discussed below. Two other options are not feasible for Mali: cold filling is eliminated because the cold chain distribution required to support such a product doesn't exist in Mali, especially at the average retailer level. Introducing cold fill packaging to Mali would be a risky venture; interruptions in the cold chain would likely cause food borne illness among consumers, and resultant lawsuits.

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<sup>7</sup> Juice is used here as a generic beverage term and actually refers actually to a nectar produced from the dilution of mango pulp with sugar and water.

Table 10. Comparison of Fruit Juice Packaging Options for Mali-produced Mango Pulp and Nectar

Type of Equipment	Equip. Cost	Package Type	Capacity	Suppliers	Comments
<b>Canning</b>	< \$40,000	200 ml–3000 ml cans	25 cans/min	Process Masters (India), others	This is dated technology, but investment costs are low. Variable costs are higher; energy (retort pasteurization), packaging material and weight during transport. 12-24 mo shelf life.
<b>Cold fill pouches</b>	\$75,000	100ml–1000 ml Pouches	25–35 pc/min	FEMAG (Fr), Bossar (Sp), Thimonnier (Fr), Volpac (Sp)	Obligated to distribute in cold chain only. 30 day shelf life in refrigerated conditions only.
<b>Hot fill pouches</b>	\$300,000–\$700,000 (depends on capacity and options)	100ml–1000 ml pouches	40–240 pc/min	FEMAG (Fr), Bossar (Sp), Thimonnier (Fr), Volpac (Sp)	Hygienic filling. Not aseptic filling, but with comparable results. Shelf life varies depending on product and pouch used (6-18mos). Can be extended with the addition of preservatives; exp. sodium benzoate. Cold chain not needed.
<b>Aseptic filled Bottles/pouches /brik</b>	\$1.8 million +	100ml–~1000ml Brick packaging, pouches or PET or HDP bottles	90–250+ pcs/min	Serac (Fr), Tetra Pak (Sw), Fogg (USA)	High investment cost. Can only be justified by huge volumes. Product is safe and shelf stable. Tetra Pak may reduce investment cost for owner to match investment capacity and then get reimbursed through the sale of the brik packaging materials

The high-volume, high-cost aseptic filling technology such as Tetra Pak is also not considered truly viable. This is both because of the elevated investment costs and the difficulty in selling the volume of products that these machines must produce in order give a return on investment. The Tetra Pak option should not be entirely disregarded though, as the potential market for Malian juice is not just in Mali, but the entire West African subregion. And, should the right product be conceived at the right price, there is a chance of making money on such a venture. Indeed, there is one Tetra Brik product on the market today with a Senegalese label: *Pressea Mango Nectar*. Nothing is known about the company that produces this product, but should an investor be interested in such technology, this might be a good company to benchmark.

## Canning

Canning would involve filling the juices or nectar in tins of various sizes. If canning is used as an option, it should be used for both the storage of mango pulp and the packaging of the mango nectar for retail sale. Canning provides a lot of flexibility in how the company operates. It is possible to run such a facility at much lower volumes than a pouch production facility, because the investment costs are low and the process operates in batches allowing for natural starts and stops. The entrepreneur could throttle production to match the market and his/her available working capital. It should be noted, however, that canning is feasible only if the company acquires a can reforming unit. This unit permits the manufacturer to import flattened can material<sup>8</sup> and then form it into cylinders with bottom prior to filling. After filling, the lids are placed on the can with the seamer. The can reforming unit and the seamer(s) are relatively inexpensive equipment (Table 10).

Such an enterprise would also benefit from the Malian consumers' familiarity with juice packaged in cans. Ivoirio, the pineapple and mixed fruit drink made in Ivory Coast, is popular in Mali, but at about FCFA 500 (~\$1.00/250ml), also beyond the buying power of many Malians citizens.

## Hot Fill Pouches

Hot filling of pouches, also termed 'hygienic filling', affords the product comparable shelf life to aseptic-filled products, but at a lower costs. The filling line, however, is not completely aseptic and thus the shelf life of the product depends on the baseline microbial load and the nature of the product itself. Artificial juice drinks with very low juice content (~10%), high acidity (< 4.2 pH) and high added sugar/water content are more stable than beverages with higher natural juice content. It is suggested that the shelf life of nectar with higher juice content could be extended by adding preservatives.

This is the second most viable option for the Malian market. The investment costs, starting at \$300 and going up to \$700, are a bit high for most Malian investors, but still within reach of some. A facility using this type of packaging machinery would have to operate at high volumes in order to get a return on investment.

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<sup>8</sup> At the time of this writing, the author had not been able to identify a supplier of the flattened cans nor get an estimate of the unit cost. These points must be determined before any investment is considered.

Hot Filled pouches are an accepted form of packaging for the Malian consumer as there are several imports of this type and one that is made locally, Mam Cocktail, whose sales volumes are just 1,000,000 liters/yr. This type of packaging allows for rather small volumes, even down to 50ml, and thus could allow the manufacture to create a product that is affordable to a broad cross section of the population. These machines operate at fairly high volumes, the lowest being 40 ppm.

## **6.2 The Investment**

This section presents an analysis of the financial viability of adding a hot fill nectar packaging machine onto the mango pulp production line to produce mango nectar for the local market. The additional investment costs would be about \$385,000. This amount would pay for the baseline hot filling machine with straw affixing attachment and the UV sterilization table for the incoming aluminum pouches. Additional investments may be required for a second pasteurization unit if the pulp and nectar lines are to be run simultaneously. Both require pasteurization immediately prior to filling. In this scenario, however, the nectar packaging line runs during the off time for the mango pulp processing line, i.e., 265 days per year.

The packaging machine made by Bossar will fill 40–50 pouches per minute. At this rate, assuming a 20-hour workday, the facility can produce 14.3 million pouches per year, just over one pouch per Malian per year. If these pouches are 0.200 ml and filled with 25% pulp, the nectar packaging line will require 716 MT of pulp per year, just 29% of total pulp production. The remainder of the pulp will be sold to the export market, generating revenue of approximately FCFA 780 million (~\$1.65 million).

## **6.3 Marketing and Sales**

The retail price point for the juice product is very critical to the success of the enterprise. If the company wants to break into Mali's mass market, it would do well to set a price point of FCFA 100. Given what we know about the costs, including the raw materials, packaging and labor, this can be done, but with difficulty.

Given the high volumes of sales, the business plan must include an extensive marketing campaign. To achieve the FCFA 100 price point, the marketing budget in this analysis is set at 5% of sales, or about FCFA 60 million (~\$126.351). In reality, however, marketing is not a variable cost based on sales. A company must spend a certain amount, whether it ultimately sells one unit or 2 million units. It must budget sufficient marketing funds to develop and distribute point-of-purchase materials and conduct a limited mass media campaign via billboards, TV and/or radio. Sponsorship of certain athletic events is also considered an effective marketing tool in Mali. Based on the sales target cited above, the FCFA 60 million budget should be sufficient once the company is operating at full capacity, but a higher marketing budget may be required during the launch phase.

## 6.4 Distribution

There are two possible scenarios for distribution: 1) The producer can set up its own distribution network and sell directly to retailers. This scenario is feasible if the primary market is Bamako and other large urban centers in Mali. 2) Alternatively, the company can sell the product to distributors and allow them to distribute to retailers. This relinquishes some control over the direct marketing efforts and placement within retailers' shops. It may be possible to set up a network of regional brokers as a means to maintain control over the point-of-purchase marketing. These brokers would represent the producer and go into retailers' shops and work with them to improve product placement and presentation. The brokers could feasibly get a small commission (2–5%) of sales in their assigned area.

In the following analysis, it is assumed that distributors in Mali take a 10%–15% mark-up on their product. It is also assumed that the average retailer mark-up is 20-35%. Retailers are most likely opportunists and take whatever margins they can get, but in general they take less of a margin on higher-volume products.

The distribution and retail sale of Coca Cola and other carbonated beverages is an example of commonly practiced margins, although it is also atypical in that Coca Cola is one of the more structured networks in Mali. We know that Bramali's distributors take a 12.5% mark-up on the product, FCFA 400 per case of soda that they acquire at FCFA 3200 and sell to the retailer at FCFA 3600. It should be noted that the distributor does not take possession of this product and therefore does not have any cash flow issues or costs of financing. Bramali also provides other services for their distributors, such as pre-financing of their vehicle fleets.

The retailers, in turn, mark up the product by 33% so that they gain FCFA 1200 /case. The retailer margin may be less for higher-volume products in this category, as is the case for PET bottled products.

It will be necessary for the company selling mango nectar to attempt to limit the retailer margins if it wants to actually hit the targeted price point of FCFA 100. Such limits might be justifiable by virtue of the fact that these pouches constitute a high-volume product.

In this scenario, it is assumed that the company manages its own distribution to the retailer and that the cost of the distribution is 8% of the sale price to the retailer. It also is assumed that the retailer takes a mark-up of just 25%. These sorts of margins are required to meet the targeted price point, but are considered the minimum possible. In this scenario, the company can make a profit, although here it is estimated at just 7% of sales.

**Table I I. Cost Analysis of 200ml Mango Nectar Pouches Produced in Mali from Mango Pulp**

***Cost Analysis of Individually Packed Nectar Pouches***

Production (Pouches per Year)	14,310,000			
	Cost / Pouch Pulp (FCFA)	% of Retail Price	TOTAL FCFA/YR	Commentary
<b>Retail Price Point (FCF/Pouch)</b>	<b>100</b>	<b>100%</b>		
Mango Pulp	12.6	12.6%	179,786,915	
Pouch	33.6	33.6%	480,816,000	at \$0.0700 / pouch
Cost sugar per pouch	1.4	1.4%	20,606,400	
Depreciation Equipment	2.7	2.7%	38,300,000	
Labor	0.8	0.8%	11,925,000	
Energy	1.0	1.0%	14,310,000	
Marketing	4.2	4.2%	60,102,000	About 5% of sales price
Distribution	6.2	6.2%	88,722,000	About 8% of sales price
Factory Mark up	5.5	5.5%	78,705,000	7% of actual sales. Profits before taxes.
TVA	12.2	18.0%	175,189,197	
<i>Sub total (price to retailer)</i>	80	80%	1,148,462,512	Sales
Retailer Mark up	20	25.0%	287,115,628	
<b>Price to Consumer</b>	<b>100</b>	<b>100%</b>	<b>1,435,578,140</b>	

## Conclusions

Mango pulp production in Mali is technically and financially feasible. There is a 12–40% profit margin in mango pulp production for the export market, depending on the scenario used. Under nearly any scenario a mango pulp production facility appears to be profitable.

Under the scenario where the company integrates a mango pulp and mango nectar line, the potential annual profits of the mango pulp line, when separated out from the adjoining nectar line, are estimated at FCFA 74 million to FCFA 332 million, depending on the cost of the raw material and the final sale price of the pulp. The potential profitability of the accompanying nectar production line also ranges from FCFA 78 million to FCFA 242 million, mostly dependent upon the acquisition price of the packaging material. Thus, the two production lines have comparable profitability.

It should be emphasized that the financial viability of the mango nectar line is highly sensitive to the cost of the packaging. In fact, it is so sensitive to this cost, that the each piece should be estimated down the hundredth of a cent. If the cost of the pouches were to be reduced from \$0.0700 to \$0.00504, the profit margin of the facility would increase from 8% to 32% and the profits go from FCFA 78 million to FCFA 242 million! This is obviously a very important cost center and the purchase of packaging material must always be negotiated with care should an investment be made into this enterprise.

The cost of the packaging is constraining simply because of the initial caveat of targeting the FCFA 100 price point. It is a very important sum for marketing and sales purposes, but rather arbitrary in terms of the actual costs of production. The owner must also realize that as costs increase over time, margins will be reduced until the decision is made to increase the price of the product to the consumer. This increase should be incremental to the currency available in the country. The next logical price point in West Africa would be FCFA 125 or maybe even FCFA 150. Certainly, the West African market, which is highly price sensitive, could react badly to any price increases, therefore it might be best to begin with a price that affords a very comfortable margin in the beginning and then allow cost increases to pare down that margin over time, until a price increase becomes absolutely necessary. As such, starting at the FCFA 100 price point might not be the best strategy despite the fact that it is a very appealing price for generating high volumes of sales in Mali.

It might be best to consider starting off at the FCFA 125 price point, or maybe even a FCFA 150 price point. If deemed palatable to the consumer, the FCFA 150 price point may be the place to start. It would provide a very interesting return on investment and could serve as the price point for many years to come, building strong customer loyalty. Indeed, with coke selling at FCFA 200 for a 33cl bottle (FCFA 6.1/ml), it is not out of the realm of possibility to offer a 20cl product for FCFA 150 (FCFA 7.5/ml). And, if the consumer is able to discern a true quality difference between products with 40% real juice as opposed to just 25%, then this would be possible for a product with a FCFA 150/pouch price point. Figure 3 shows the results under such a scenario. The profits are 17% of sales and over FCFA 200 million annually. The values for marketing (set at 8% of sales), distribution (set at 13% of sales) and retailer margin (33%) are also much more realistic than under the FCFA 100 per pouch scenario. Some consumer testing may be warranted to determine the best price point, but the FCFA 150 price point should certainly be considered.

**Table 12. Cost Analysis of Mango Pulp Pouch at the FCFA 150 Price Point**

***Cost Analysis of Individually Packed Nectar Pouches***

Production (Pouches per Year)	14,310,000			
	Cost / Pouch Pulp (FCFA)	% of Retail Price	TOTAL FCFA/YR	Commentary
<b>Retail Price Point (FCF/Pouch)</b>	<b>150</b>	<b>100%</b>		
Mango Pulp	12.6	8.4%	179,786,915	
Pouch	33.6	22.4%	480,816,000	at \$0.0700 / pouch
Cost sugar per pouch	1.4	1.0%	20,606,400	
Depreciation Equipment	2.7	1.8%	38,300,000	
Labor	0.8	0.6%	11,925,000	
Energy	1.0	0.7%	14,310,000	
Marketing	9.5	6.3%	135,945,000	About 8% of sales price
Distribution	15.0	10.0%	214,650,000	About 13% of sales price
Factory Mark - up	19.0	12.7%	271,890,000	17% of actual sales. Profits before taxes.
TVA	17.2	18.0%	246,281,277	
<i>Sub total (price to retailer)</i>	113	75.2%	1,614,510,592	Sales
Retailer Mark up	37	33.0%	532,788,495	
<b>Price to Consumer</b>	<b>150</b>	<b>100%</b>	<b>2,147,299,087</b>	

Based on the analysis, a company seeking to process and sell mango pulp for export has one clear path to short-term profitability and possibly less risky than entering the production of nectar for the local market. Integrating the mango nectar option, however, leaves open the possibility for much greater upside benefits. In the above scenarios, only 30% of the mango pulp was diverted to nectar production. If an investor in a mango nectar filling line can control the costs of production and distribution over time and simultaneously gain strong brand recognition for the product in Mali and the West African subregion, the potential for growth in sales and absolute profits are much greater than for mango pulp export alone. This is especially true if the FCFA 150/pouch price point proves acceptable to the consumer.

Additionally, the value added per kilogram of fresh mango is greatest under mango nectar production at \$1.60/kg. The value addition for the conversion of fresh mango to mango pulp is just \$0.30. This difference is explained mostly by the fact that the conversion of fresh mangoes

to nectar is 200%, meaning that one obtains 2Kg of nectar from 1Kg of fresh mangoes due to the addition of sugar and water to the pulp. On the other hand the conversion of fresh mangoes to pulp is merely 50%; i.e. it takes 2Kg of fresh mangoes to make 1Kg of pulp (Table 13).

From a development perspective and a macro economic perspective, it is clear that converting mangoes to mango nectar sold in the national marketplace is the best opportunity. This also holds true in the comparison between fresh mango export and mango nectar production. Table 13 shows that mango nectar production outperforms even fresh mango exports from a value added standpoint.

Table 13 also compares the value added potential of fresh mango exports with mango pulp production. Fresh mango exports have more than three times the value addition potential than mango pulp production; at \$1.00/kg. This illustrates that, despite the limited 'processing' done for fresh mango exports, there is value in developing the supply chain logistics to export fresh mango. And, from a development perspective, if one were left with the option of promoting either fresh mango export or mango processing for pulp, the best option would be to promote fresh mango export.

**Table 13. Potential for Value Addition via Malian Mango Products**

<b>Fresh Mango Export</b>			
Revenue Fresh Mango Export	\$/kg	\$	1.50
<u>COGS</u>			
Raw Material (fresh mango)	\$/kg	\$	0.13
Packaging	\$/kg	\$	0.38
COGS Fresh Mango Export TOTAL	\$/kg	\$	0.50
Sale Price of Fresh Mango Export	\$/kg	\$	1.50
Value Added Fresh Mango Export	\$/kg	\$	1.00
Conversion RM (mango) to fresh export	%		100%
<b>Value Added Fresh Export / kg RM (mango)</b>	<b>\$/kg</b>	<b>\$</b>	<b>1.00</b>
Labor Costs	\$/kg	\$	0.00
Depreciation / kg fresh export	\$/kg	\$	0.04
EBIT Fresh Mango	\$/kg	\$	0.96
<b>EBIT Fresh Mango / kg RM (mango)</b>	<b>\$/kg</b>	<b>\$</b>	<b>0.96</b>

<b>Pulp</b>			
Revenue Mango Pulp	\$/kg	\$	1.20
<u>COGS</u>			
Raw Material (fresh mango)	\$/kg	\$	0.17
Energy	\$/kg	\$	0.02
Packaging	\$/kg	\$	0.41
COGS Pulp TOTAL	\$/kg	\$	0.59
Value Added Pulp	\$/kg	\$	0.61
Conversion RM (mango) to pulp	%		50%
<b>Value Added Pulp / kg RM (mango)</b>	<b>\$/kg</b>	<b>\$</b>	<b>0.30</b>
Labor Cost	\$/kg	\$	0.04
Depreciation / kg pulp	\$/kg	\$	0.03
EBIT Pulp	\$/kg	\$	0.54
<b>EBIT Pulp / kg RM (Mango)</b>	<b>\$/kg</b>	<b>\$</b>	<b>0.27</b>

<b>Nectar</b>			
Revenue Nectar	\$/kg	\$	1.30
<u>COGS</u>			
Raw Material (nectar)	\$/kg	\$	0.17
Raw Material (sugar)	\$/kg	\$	0.07
Energy	\$/kg	\$	0.05
Marketing	\$/kg	\$	0.04
Packaging	\$/kg	\$	0.18
COGS Nectar TOTAL	\$/kg	\$	0.50
Value Added Nectar	\$/kg	\$	0.80
Conversion RM (mango) to nectar	%		200%
<b>Value Added Nectar / kg RM (mango)</b>	<b>\$/kg</b>	<b>\$</b>	<b>1.60</b>
Labor Cost Nectar	\$/kg	\$	0.01
Depreciation Nectar	\$/kg	\$	0.04
EBIT Nectar	\$/kg	\$	0.75
<b>EBIT Nectar / kg RM (mango)</b>	<b>\$/kg</b>	<b>\$</b>	<b>1.51</b>

## **Annex A**

### **Specification Sheet for Mango Pulp<sup>9</sup>**

#### **Alphonso Mango Pulp**

Pulp extracted from sound mature and ripe Alphonso mangoes, packed aseptically.

##### **Chemical Profile**

- Brix 16
- % Acidity (as Citric) 0.5% - 1.0%
- pH 3.6 - 4.2
- Crude Fibre 0.2%

##### **Organoleptic**

- Colour Bright yellowish Orange
- Flavour Typical Ripe Alphonso Mango
- Taste Wholesome and characteristic of Alphonso Mango
- Appearance Homogenous & uniformly free flowing

##### **Microbiology**

- Total Plate Count <50 CFU per gm
- Yeast and Mould count Nil
- E. coli Absent
- S. aureus Absent

##### **Packing**

- 200 kgs per drum
- 25kg bag in box
- [A10 OTS Cans (3.1 Kg)]

#### **Totapuri Mango Pulp**

##### **Chemical Profile**

- Brix 14
- % Acidity (as Citric) 0.4% - 0.8%
- pH 3.8 - 4.5
- Crude Fibre 0.4%

##### **Organoleptic**

- Colour Golden Yellow
- Flavour Typical Ripe
- Taste Wholesome and characteristic of Mango
- Appearance Homogenous & uniformly free flowing

##### **Microbiology**

- Total Plate Count <50 CFU per gm
- Yeast and Mould count Nil
- E. coli Absent
- S. aureus Absent

##### **Packing**

- 200 kgs per drum
- 25kg bag in box

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<sup>9</sup> The following specifications for mango pulp are from Juice World Ltd. (15 Southgate, Chichester. PO19 1ES, West Sussex. England) [www.juiceworld.net](http://www.juiceworld.net) (accessed ).

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